Components in wireless technologies (5XTC0)

Modules 6: Lab Amplifier measurements

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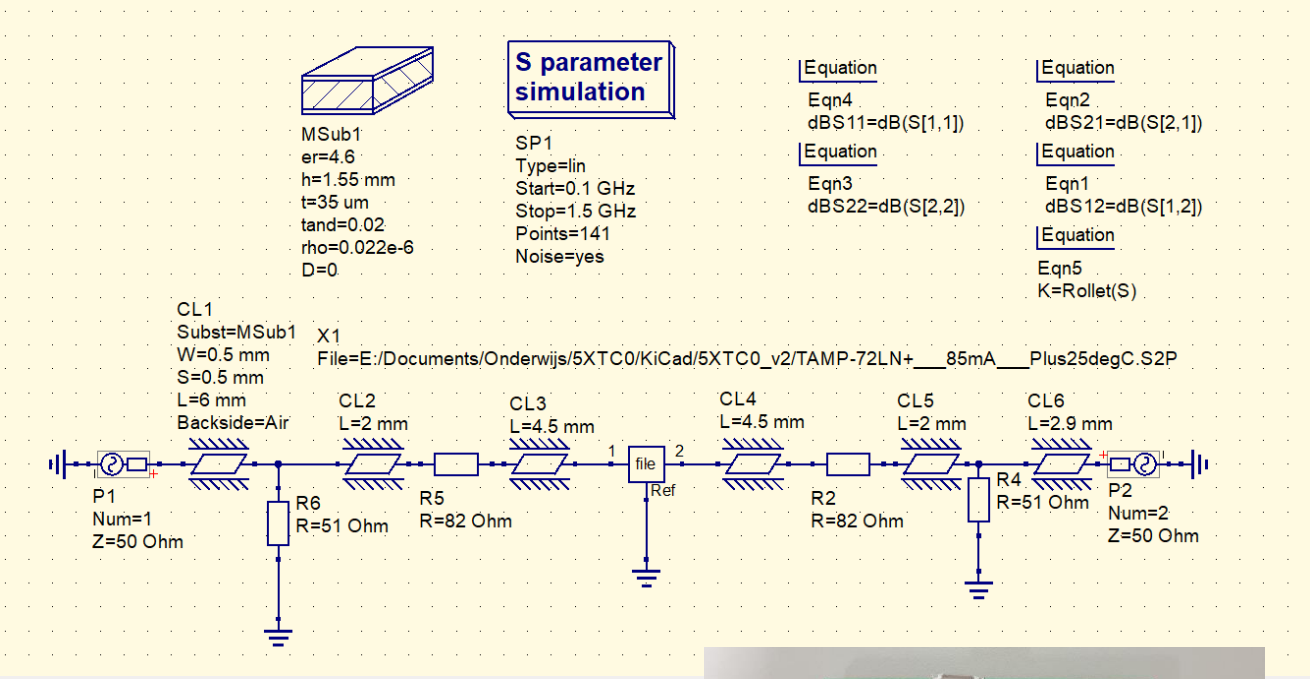
Reporting

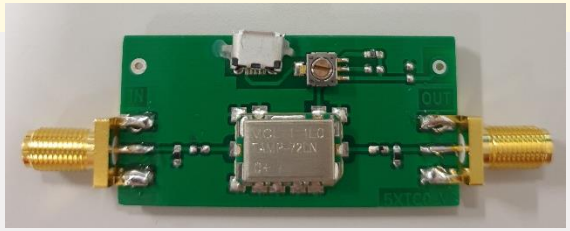
- Upload a small report with your answers of this lab and the previous lab (Module 5: QUCS amplifier design/simulation) to Canvas before Friday March 28th, 23:59. Please note your name in the file, as well as in the filename.

- During the oral exam you'll get questions about the labs.

Amplifier board

5XTC0_V2 Amplifier board schematic as you made during Module 5 Lab: QUCS amplifier design

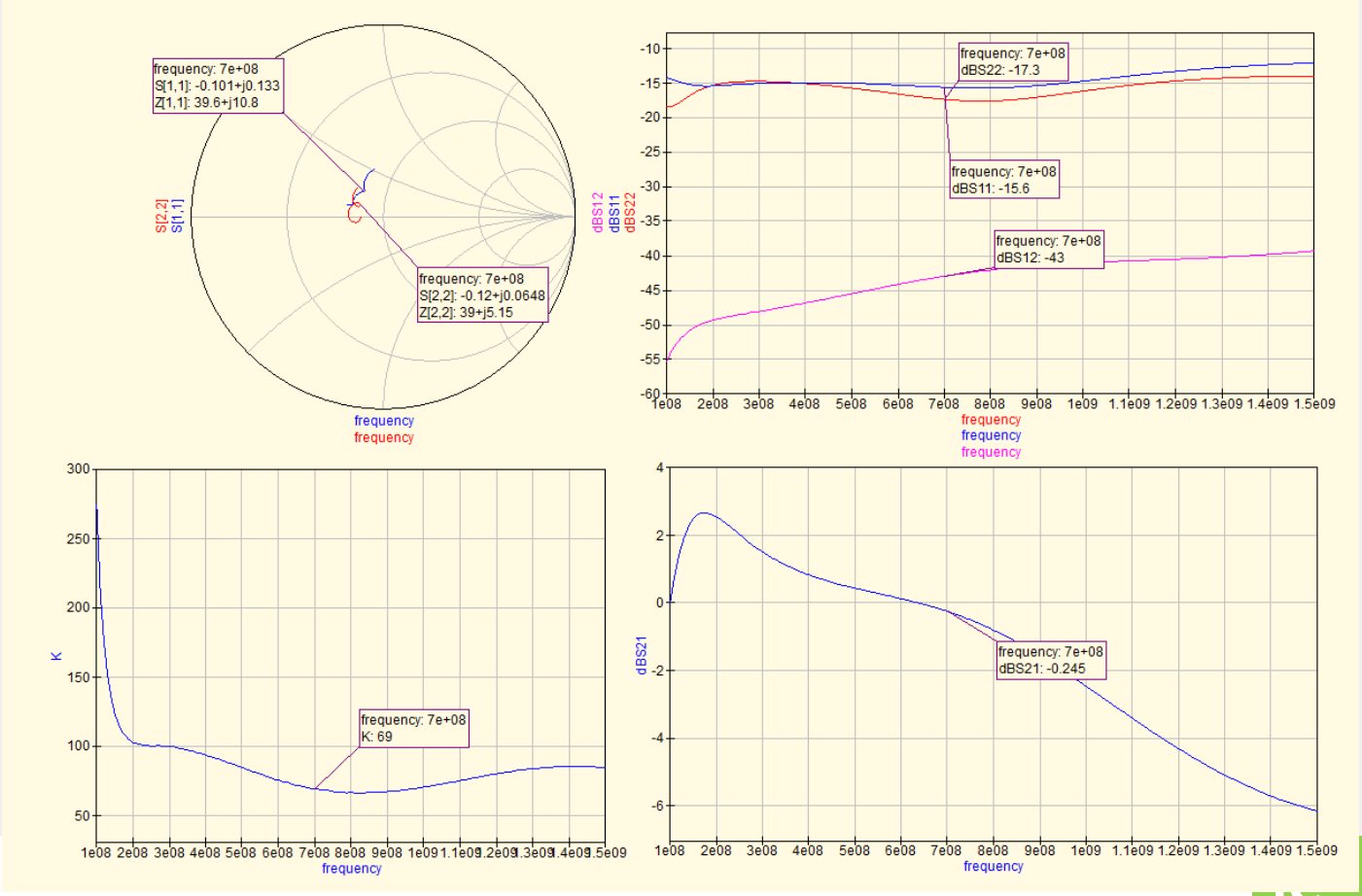




Picture of the amplifier board

Simulated amplifier board

Simulated results of the amplifier board.



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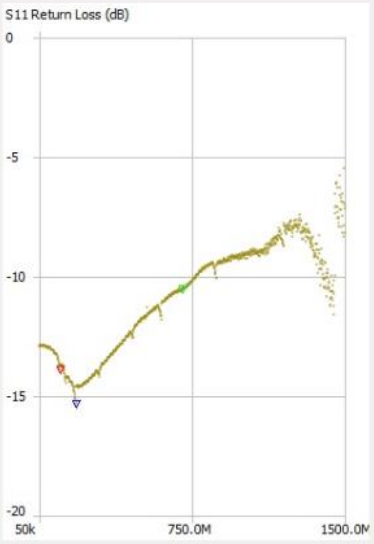
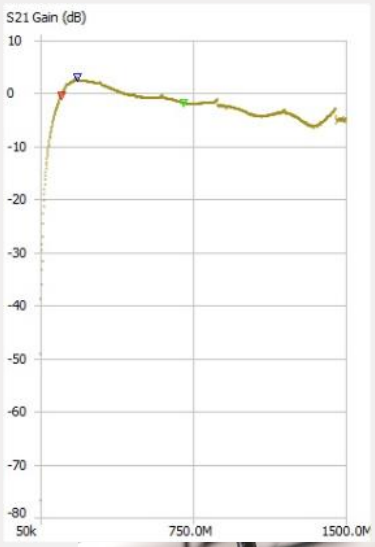
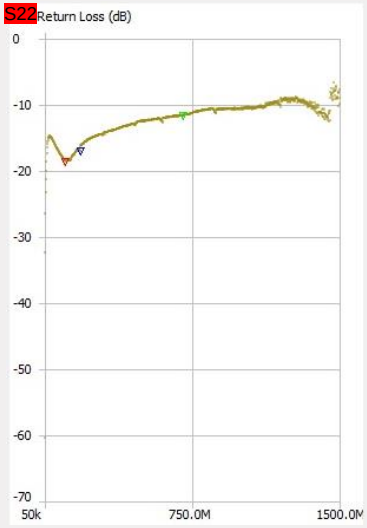
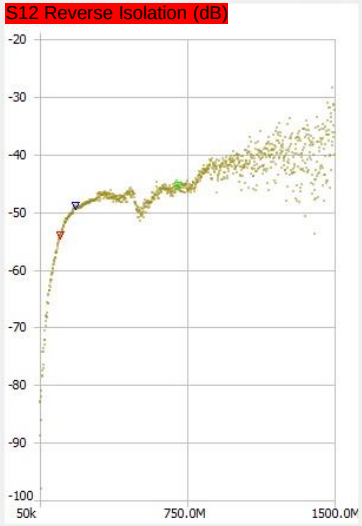
Measured amplifier

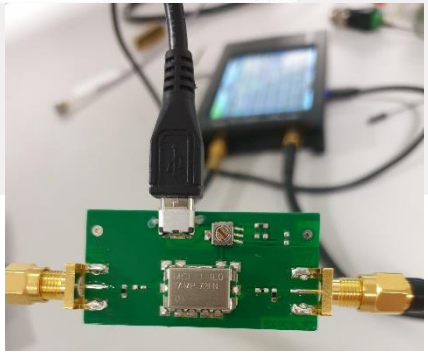
Measured S11, S22, S21, S12 parameters of the 5XTC0_V2 amplifier board with NanoVNA from 50kHz till 1.5GHz in 10 segments, 3 averages after calibration.











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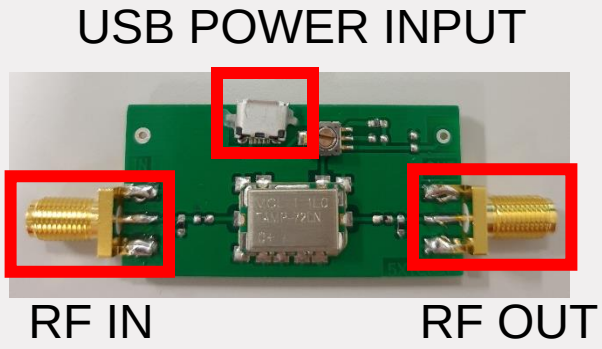
Measurement procedure 1/3

1. Power up the NanoVNA.
   Make 2 traces with S11 and S21 visible.
   Set the frequency range as large as possible;
   from 50kHz till 1.5GHz

2. Calibrate the NanoVNA as you have learned during Module 2, Lab: VNA measurement of passives.
   Use the M-M cables and the female standards for this calibration. Leave the cables connected to the NanoVNA.

3. Connect the amplifier board RF input (SMA connector with text IN) to CHAN0 of the NanoVNA using the same still attached M-M cable.
   Connect the amplifier board RF output (SMA connector with text OUT) to CHAN1 using the other still attached M-M cable.

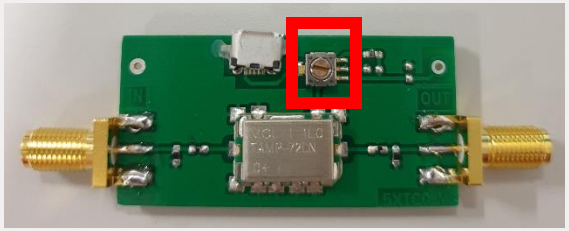
4. Save the result of this measurement into a file. This is without biasing the amplifier.



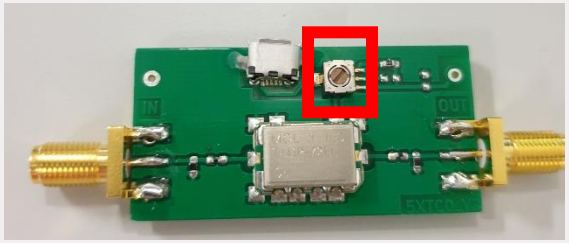
Measurement procedure 2/3

5. Check the power switch on the amplifier board. Set the switch in horizontal position (“OFF”) when it is not. You can use a small screwdriver, knife, fingernail or whatever you have available.
6. Connect the USB cable to a USB port (laptop/power plug) and to the amplifier board.
7. Turn the power switch clockwise a bit so it is in the same position as noted on the picture “5V”. The amplifier board is now biased with 5V and about 85 mA.
8. Look at the measurement results on the NanoVNA and save these. Now turn the switch counterclockwise as noted in the picture “1.4V”. The amplifier board is now biased with 1.4V and about 20 mA.
9. Look at the measurement results on the NanoVNA and save these.

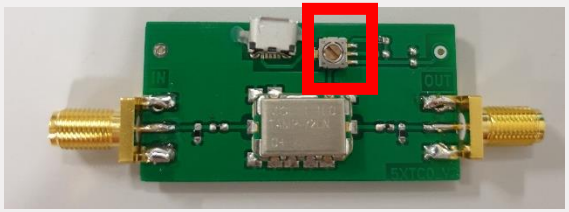
Power switch:



OFF



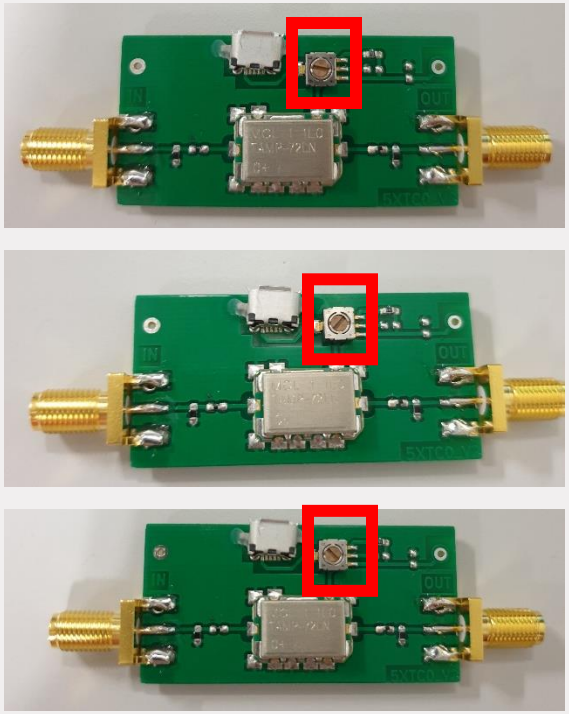
1.4V



5V

Measurement procedure 3/3

10. Set the power switch to “OFF” again.
11. Disconnect the RF cables from the SMA ports on the amplifier board. Swap the connections around to connect CHAN0 to RF OUT and CHAN1 to RF IN.
    By swapping the cables we can now measure S22 (instead of S11) and S12 (instead of S21).
12. Set the power switch to “5V” again. The amplifier board is now biased with 5V and about 85 mA.
13. Look at the measurement results on the NanoVNA and save these.



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Assignments

Add the questions below with your answers to the answer template for Module 6.
Submit your answers before Friday March 28th 23:59.
You will get questions about this during the oral exams on April 2nd and 4th.

1. Look at the S-parameters you have measured with 5V and 85mA biasing. Do they match the simulated s-parameters in QUCS? Can you explain the difference?

2. We have mentioned in the previous lab (QUCS amplifier design/simulation) that we had to limit the input and output of the amplifier board not to put the receivers of the NanoVNA into compression.
   On the RF input side, you see two resistors of 82 Ohm and 50 Ohm. How much attenuation in dB does these resistors give?

3. When we changed the switch from 5V/85mA to 1.4V/20mA, we placed an extra resistor in series to bias the amplifier differently. Which resistor (value) is placed there?

4. Which output power does the NanoVNA supply to the amplifier (check datasheet of NanoVNA)?
   Which input power can the amplifier handle? Is it within limits?

   As frequency of interest for the next question, use 700 MHz.

5. You have just looked up the output power of the NanoVNA at assignment 4 and the attenuation of the resistors on the input at assignment 2. What is then the input power presented at the input of the amplifier module? And what is the output power of the total amplifier board taking the gain of the amplifier and output attenuation into account?